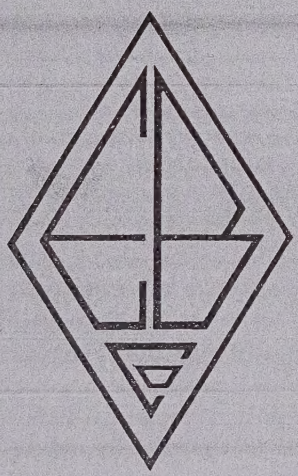
# OPERATING AND MAINTENANCE INSTRUCTIONS

for

# STROBOSCOPE

## MODEL 510-A

## MODEL 510-AL



ELECTRONIC BRAZING COMPANY

MONTCLAIR, NEW JERSEY

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## MODEL 510-A

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ELECTRONIC BRAZING COMPANY

MONTCLAIR, NEW JERSEY

October 1958

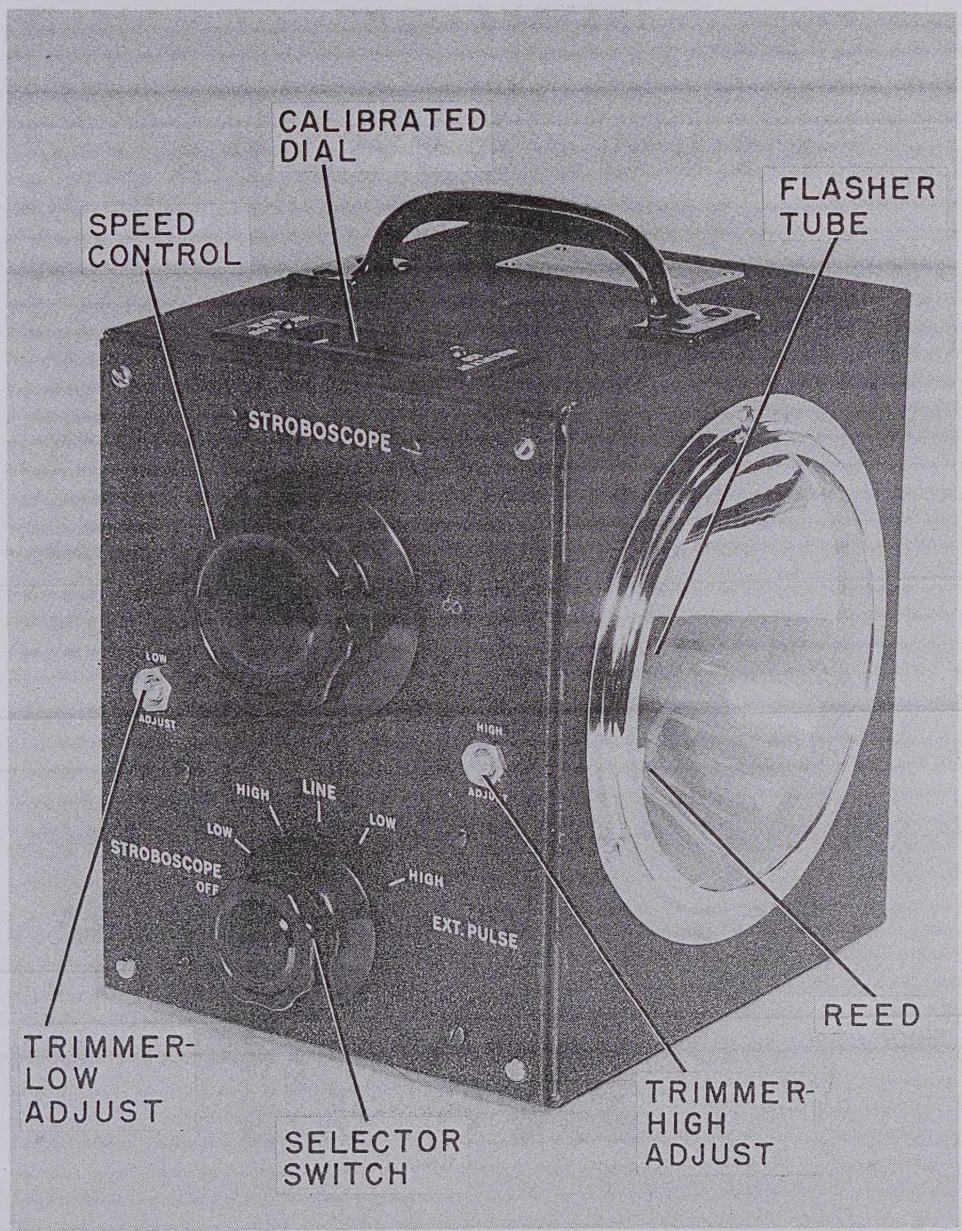


Figure 1. Stroboscope, Front View

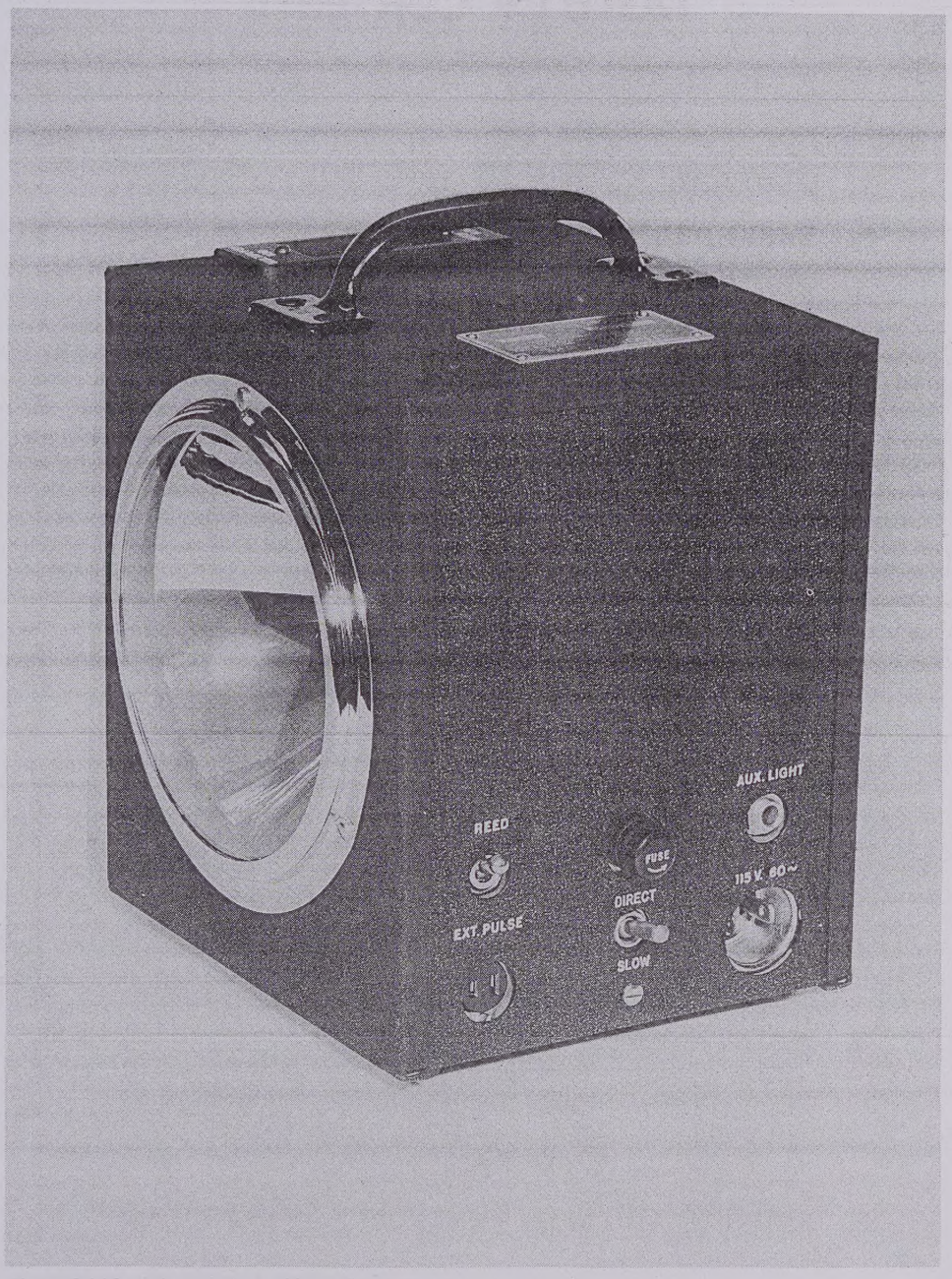


Figure 2. Stroboscope, Rear View

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# OPERATING AND MAINTENANCE INSTRUCTIONS FOR STROBOSCOPE

## MODEL 510-A

## MODEL 510-AL

1. GENERAL.

The Model 510-A Stroboscope is an electronic tachometer. It provides a direct and accurate means of measuring any speed from 600 rpm to 15,000 rpm. The Model 510-AL Stroboscope provides an additional low range, extending operation to 60 rpm. The Model 510-A and Model 510-AL Stroboscopes are especially flexible in application, for no mechanical connection is required; therefore no power is absorbed from the device under observation.

2. BASIC PRINCIPLE.

Stroboscopic effects may be produced when an intense light, of short duration, is repeated at precise intervals. If this light is directed upon a rotating or vibrating object, the stroboscopic effect will be observed when the repetition frequency of the light is in proper ratio to movement frequency.

If the frequency of movement and light repetition are exactly matched, the moving object will be viewed distinctly only once each cycle. The object will appear to be stationary, since it will be illuminated by the flash of light at precisely the same phase of each cycle. This "single image" apparent cessation of motion will also occur when the light frequency is a submultiple (half, third, quarter, etc.) of movement frequency. Multiple images occur when the light frequency is a multiple of movement frequency. This phenomenon occurs because the moving object is illuminated more than once each cycle (see para. 7.3).

Satisfactory stroboscopic effects will occur only when the pulsed light is more intense than the ambient light, and the light pulses are short enough to prevent smear or blur.

The Model 510-A Stroboscope produces a brilliant blue-white flash of 0.75 to 1.5 microseconds duration, and is usable under normal daylight conditions, provided direct sunlight is avoided.

## 3. DESCRIPTION.

The Stroboscope operates from a 115-volt, 60 cycle a-c power line. It consists of a power supply, oscillator, pulse amplifier, and a flasher tube. The complete unit is mounted in an easily portable metal case. The flashing rate is varied by turning a calibrated illuminated dial. Frequency range is from 600 to 15,000 flashes per minute. A vibrating reed, oscillating at double line frequency (7200 cycles per min), is mounted just under the flasher tube to permit adjustment of calibration.

3.1 Accuracy. Nominal accuracy is ±1% when the instrument has been calibrated by reference to power line frequency. In addition greater accuracy can be obtained over any small range by calibrating to a harmonic of line frequency (see section 7). The slow position on the Model 510-AL provides a flashing rate of approximately 1/10 scale values. Accuracies of 5 to 7% may be obtained, although calibration by visual means may be difficult when the frequency of light repetition falls below the limits of 10-15 flashes per second required for "persistence of vision".

## 4. OPERATION.

Connect Stroboscope to 60-cycle power line, using power cord provided and receptacle on rear of case.

4.1 Controls. The selector switch on front of case turns the set on and off, and selects operating condition as marked on front panel. There are three main functions; first is "STROBOSCOPE LOW AND HIGH," where flashing rate of tube is controlled by rotation of calibrated dial. Second is "LINE" where flashing rate is controlled by line frequency. Third is for controlling flashing rate by a signal from an external source. Use "LOW" position for input signal frequency below 3600 rpm, and "HIGH" when frequency is over 3600 rpm.

4.1.1 Dial. The calibrated dial is a back-lighted type, read from a window on top of the case. The internal oscillator should be adjusted, to properly align its frequency with dial indications, before using the instrument to measure speed. The vibrating reed and two trimmer potentiometers are used for this purpose.

4.2 "STROBOSCOPE". Turn selector switch to "Stroboscope High" position, tube will flash in 15-20 seconds; allow several minutes for warm up to stabilize circuit.

4.2.1 "CALIBRATION-HIGH". Turn reed switch on and set dial to 14,400 on high scale. Use a screw driver or coin to turn "High Adjust" trimmer until reed motion appears stopped. Next set dial to 3600 on low end of high scale, and turn "Low Adjust" trimmer until reed appears stopped. A final check and small re-adjustment should be made at both 14,400 and 3600 once again to assure an accuracy of approximately 1%. When operating at any particular frequency, accuracy can be improved by making trim adjustments over a narrow range (see paragraph 7.1).

NOTE

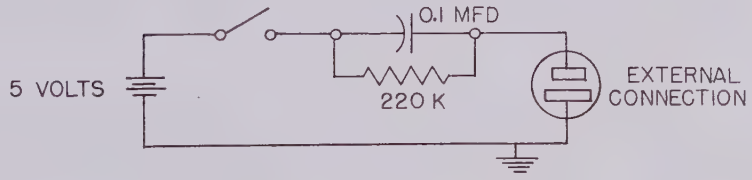
At 14,400 a double image will be seen (see paragraph 7.1).

4.2.2 "CALIBRATION-LOW". An internal potentiometer, R106, is used to align the high and low scales at the time of manufacture and testing. Therefore, when the high scale has been carefully aligned the low scale will give satisfactory readings. However, if it is desired to calibrate the low scale, use the same procedure as outlined in paragraph 4.2.1, substituting 3600 for High and 900 for Low check points.

4.3 "LINE". When selector switch is turned to this position, the flasher tube is operated at line frequency (3600 rpm). This frequency may be used to observe certain classes of synchronous electrical equipment, or to measure, slip, or hunt in small motors or mechanisms. Accuracy is equal to line frequency.

4.4 "EXTERNAL PULSE". With the selector switch in this position, the frequency of the flasher tube may be controlled by

an external source such as a mechanical contactor or signal generator. A small two-pole receptacle is provided for connection to the external source. Voltage input should range between 5 to 50 volts peak. For frequencies less than 3600 use "LOW" position, over 3600 use "HIGH" position in order to avoid overload on flasher tube. A circuit similar to that shown below may be used for external pulsing.




Circuit for External Contactor

4.5 Auxiliary Light. A jack at the rear of instrument case is provided for triggering an external light source. A pulse, directly from the flasher tube, is available for triggering an auxiliary light, such as the General Radio Strobolux.

## 5. USE.

The Stroboscope may be used as an electronic tachometer or timing device. It is also a light source for stroboscopic observation of equipment in motion. Moving equipment can be studied in either the steady "stopped" state or in apparent slow motion.

**CAUTION**

> The illusion of stopped motion is very convincing.
> Do not attempt to touch moving equipment.

5.1 Speed Measurement. In use, hold the Stroboscope so that light from the tube falls on the part to be observed.

If the part is uniform or symmetrical, place an identification mark with chalk or crayon on the portion to be viewed. Adjust the large knob controlling frequency until the part appears to be stationary. The dial will read revolutions per minute. If speed

is unknown, start at a high speed and work down until a single stationary image is obtained. (See paragraph 5.2).

5.1.1 Speed Versus Range. Since tube life is dependant upon operating conditions, certain ranges are more favorable for longer life. By reference to figure 2 it may be seen that flasher tube wattage increases rapidly with speed, and is greater at some portions of low range than at equal or higher speeds on high range. Tube life is best when operated at less than 5 watts.

When Stroboscope is to be used on a long duty cycle it is suggested that a submultiple of fundamental speed be used. The pattern will be equally stationary, with tube life greatly extended. In addition, the light quality is better at lower ranges than at the top end of the scale.

5.2 Fundamental Frequency. In measuring unknown speeds, it is necessary to start at some higher value and work downward. When Stroboscope speed exceeds that of moving object, multiple images will be seen; the first single stationary image will be seen at fundamental frequency. (See paras. 5.4 and 7.3).

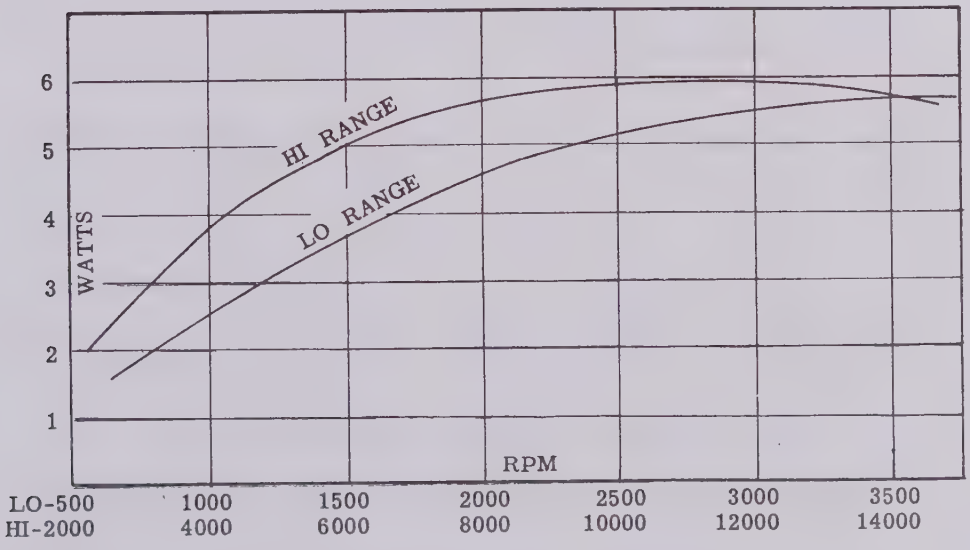



Figure 3. Flasher Tube, RPM/WATTS

5.3 Submultiples. If the Stroboscope is operated at a speed less than the fundamental frequency, single images will be seen at 1/2, 1/3, 1/4, ... $\frac{1}{N}$ of the speed of moving part.

5.4 Multiple of Frequency. If Stroboscope flashes "N" times speed of moving object, "N" images will be seen.

## 6. EXTENDED RANGE.

Speeds above or below dial range can be measured by the use of multiple or submultiple synchronism.

6.1 High Speed. When the speed of a rotating object is greater than 15,000 rpm, the speed may be computed as follows:

a. Obtain a stationary single image at a subharmonic, and record the dial reading as "A".

b. Obtain a second stationary single image at the next lower subharmonic, and record dial reading as "B".

c. Use the formula $\frac{AB}{A-B}$ to compute rpm. For example,

let A = 4000 and B = 3500, then rpm =

$$\frac{4000 \times 3500}{4000 - 3500} = \frac{14,000,000}{500} = 28,000 \text{ rpm}$$

At higher speeds where the value of A-B becomes progressively smaller, accuracy can be increased by dropping B to a lower submultiple and using the formula $N\frac{AB}{A-B}$. Values for A and B would be obtained as above; N would be the number of submultiples used. For example; A = 4000, B = 2000. In going from 4000 to 2000 on the dial, seven single stationary images will be observed in addition to "A" (4000). Therefore $N\frac{AB}{A-B}$ =

$$7 \times \frac{4000 \times 2000}{4000 - 2000} = 7 \times \frac{8,000,000}{2000} = 7 \times 4000 = 28,000 \text{ rpm}$$

This same formula may be used to verify readings at any speed, even when the fundamental is within the range of 600-15,000 rpm.

6.2 Low Speed. At low speeds a multiple image will be seen, the number in direct proportion to speed as read on dial, divided by speed of rotating object. For example, let A = dial reading (900), B = shaft speed (450), then $\frac{A}{B} = \frac{900}{450} = 2$ images.

## 7. USEFUL INFORMATION.

A vibrating reed is mounted under the flasher tube and serves as a reference for accurately calibrating the Stroboscope.

7.1 Reed Frequency. The reed vibrates at double line frequency, 7200 cycles per minute on a 60-cycle power line. Advantage may be taken from its steady rate of oscillation to standardize the scale over a narrow range for very precise measurements. If the flasher tube is operated over its full range of frequency, a steady single image of the reed will be seen at 7200, 3600, 2400, 1800, 1440, 1200, 900, 800, 720, 600 rpm. A double image appears at 14,400 rpm. Stationary images in various multiples can be seen at other points along the dial but, due to the complexity of calculation, it is best to use only single images and the one double at 14,400 rpm.

7.2 Narrow Range Calibration. Fit the required frequency between any two of the single image frequencies (including 14,400) listed above. Set the dial at higher value and adjust "HIGH" trimmer on the front panel. Then set dial to lower value and adjust "LOW" trimmer on front panel. Within the range between the two points of adjustment, Stroboscope accuracy will approach that of power line accuracy. In most commercial power lines, frequency is controlled to better than .1%.

7.3 Additional Stationary Images. Stationary images will appear at other fractional values of reed frequency. The number of images will be equal to the numerator of the fraction, when the fraction has been reduced to its lowest terms. Single images will be seen at 1/1, 1/2, 1/3, etc; double images will be seen at 2/1, 2/3, 2/5, etc; triple images will be seen at 3/1, 3/2, 3/4, etc; etc.

| FREQUENCY FLASH--CPS | SETTING DIAL--RPM | RATIO DIAL/REED | NUMBER IMAGE |
|---|---|---|---|
| 10 | 600 | 1/12 | 1 |
| 12 | 720 | 1/10 | 1 |
| 13.3 | 800 | 1/9 | 1 |
| 15 | 900 | 1/8 | 1 |
| 20 | 1200 | 1/6 | 1 |
| 24 | 1440 | 1/5 | 1 |
| 30 | 1800 | 1/4 | 1 |
| 40 | 2400 | 1/3 | 1 |
| 60 | 3600 | 1/2 | 1 |
| 80 | 4800 | 2/3 | 2 |
| 120 | 7200 | 1/1 | 1 |
| 180 | 10800 | 3/2 | 3 |
| 240 | 14400 | 2/1 | 2 |

Figure 4. Steady Images - Useful for Calibrating

## 8. MAINTENANCE.

8.1 Flasher Tube Life. Flasher tube life is a variable, dependent upon operating frequency and length of duty cycle. Under the most favorable conditions of low frequency and short duty cycle, life can run as high as 1000 hours, while at higher frequency and long duty cycle, life is shortened to 200-300 hours (see paragraph 5.1.1).

8.2 Flasher Tube - Polarity. The S55B flasher tube is not polarized, it is however, used in a d-c circuit so that one side becomes the cathode and the other the anode. In use, one electrode receives an electron bombardment, and the glass in this region becomes darkened with usage. Emission is lowered with age and light intensity is diminished. Light intensity can be restored and tube life extended if polarity is reversed after a noticeable darkening has occurred. Reversal of polarity can be accomplished by rotating the tube in its socket. The socket is wired so that the tube may be inserted in a 1-3-5 or a 2-4-6 position, thereby reversing polarity.

8.3 Replacement - Flasher Tube. Remove the bezel ring and glass from in front of the reflector, and replace flasher tube. Carefully center glass over rubber pads and reinstall bezel ring; three small bright plated screws are used for attachment.

8.4 Replacement of Other Tubes. Remove the entire chassis from the case to replace other tubes. Four bright plated screws on front panel and one screw at rear hold the chassis to case. Be sure reed switch is "off" (down position) when replacing chassis in case. Install and tighten all five screws.

## 9. SERVICE AND MAINTENANCE INSTRUCTIONS.

The following instructions, in conjunction with the information given in the Operation Instructions, should enable the user to correct ordinary troubles encountered in normal use.

The majority of the components can be found by reference to the photographs. Difficult problems should be referred to the Service Department for correct information and instructions. If the instrument is older than one year, and is returned to the manufacturer, a reasonable charge may be expected for replacement of parts, or for complete reconditioning. Detailed information containing serial numbers of instrument and parts, plus operating conditions, must be included in the report to the Service Department.

## PARTS LIST, STROBOSCOPE, MODELS 510-A AND 510-AL

| | |
|---|---|
| C101 | .008 Mfd ± 2% 500 V |
| C102 | .008 Mfd ± 2% 500 V |
| C103 | 820 Mmfd ± 20% 500 V |
| C104 | 1000 Mmfd ± 20% 500 V |
| C105 | .0047 Mfd ± 20% 500 V |
| C106A | 0.4 Mfd ± 10% 600 V |
| -B | 0.6 Mfd ± 10% 600 V |
| C107A-B | 10-10-10-10 Mfd 450 V |
| -C-D | |
| C108 | .003 Mfd ± 20% 500 V |
| C109 | 1500 Mmfd ± 20% 500 V |
| C110 | .062 Mfd ± 5% 600 V |
| C111 | .062 Mfd ± 5% 600 V |
| | |
| F101 | 1.0 Amp Fuse |
| I 101 | 6 Volt Pilot Lamp |
| I 102 | Vibrating Reed |
| J 101 | Ext. Pulse Receptacle |
| | |
| J 102 | AC Line Receptacle |
| J 103 | Aux. Light Jack |
| L101 | Choke 6 henries |
| | |
| R101 | 27K ± 5% 1 W |
| R102 | 27K ± 5% 1 W |
| R103 | 3M ± 1% 1 W |
| R104 | 1M ± 10% 1/2 W |
| R105 | 2.2M ± 10% 1/2 W |
| R106 | 1M Potentiometer ± 10% |
| R107 | 1M ± 1% 1/2 W |
| R108 | 47K ± 5% 2 W |
| R109 | 200K Potentiometer ± 10% |
| R110 | 50K W.W. Potentiometer ± 5% |
| R111 | 5K W.W. Potentiometer ± 10% |
| R112 | 10K ± 10% 2 W |
| R113 | 2.2M ± 10% 1/2 W |
| R114 | 150K ± 10% 1 W |
| R115 | 68K ± 10% 1/2 W |
| R116 | 8.2K ± 10% 1/2 W |
| R117 | 82K ± 10% 2 W |
| R118 | 6000 Ohm ± 10% 20 W |
| R119 | 10K ± 10% 1/2 W |
| R120 | 1.2K ± 10% 2 W |
| | |
| S101A-B | Selector Switch, |
| -C-D | 4 pole, 5 position |
| -E | Line |
| S103 | SPST Toggle Switch |
| S104 | DPDT Toggle Switch |
| | |
| T101 | Pulse Transformer |
| T102 | Power Transformer |
| | |
| V101 | 12 AU 7 |
| V102 | 6SN7 GTA |
| V103 | 6X4 |
| V104 | S55-B |

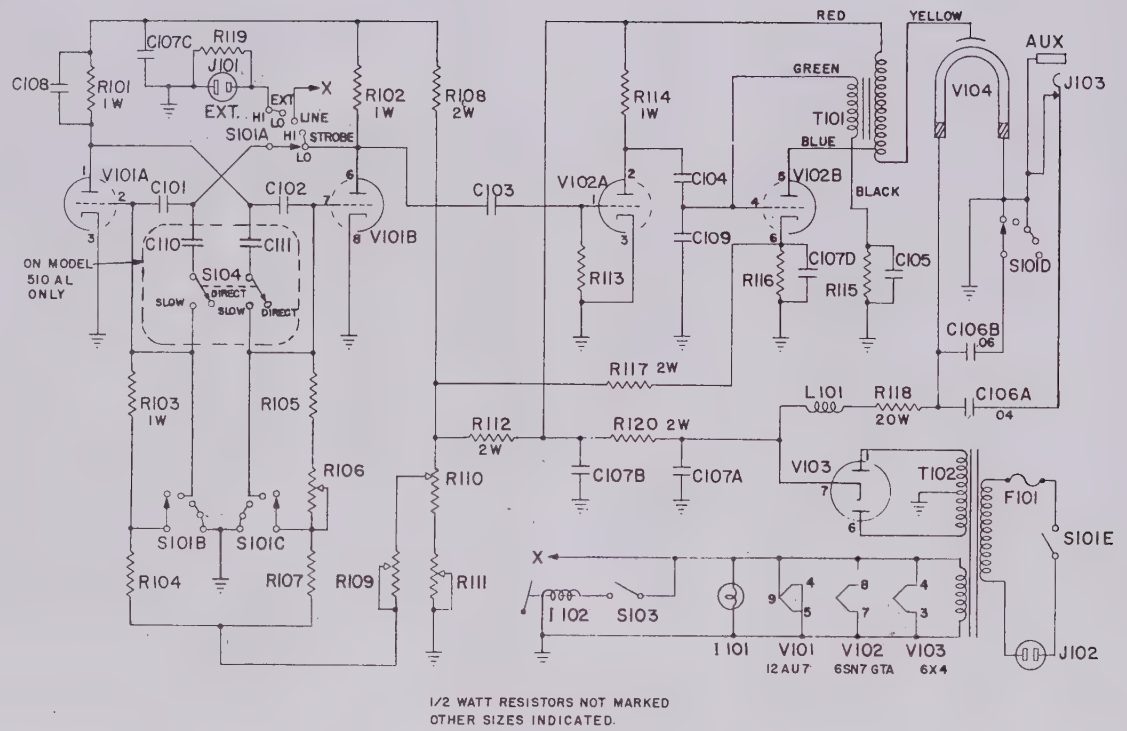



Figure 5. Schematic Diagram, Stroboscope, Models 510-A and 510-AL

9.1 GENERAL. If the Stroboscope becomes inoperative, a few simple checks should be made before the instrument is removed from the case.

a. Make sure voltage and frequency of power line are correct.
b. Check power cord for open circuit and power outlet for poor contact.

9.2 STROBOSCOPE BLOWS FUSES.

a. Check V103 (6X4), and operating voltages.
b. Check C107-A-B-C-D for shorts to ground.
c. Check R118, and C106-A-B for shorts to ground.

9.3 REED WILL NOT VIBRATE.

a. Measure voltage across coil; it should be 6.3 v ac.
b. Check S103 for open circuit.
c. Check reed coil for open circuit.

9.4 DIAL LAMP DOES NOT LIGHT.

a. Check Lamp I101 for open circuit. Turn the scale and hub assembly until slot in the hub is opposite the lamp. Complete unit can be withdrawn, using long nose pliers.
b. Check fuse for open circuit.
c. Check T102 for open winding.

9.5 FLASHER TUBE OPERATES ERRATICALLY.

a. Replace V101.
b. If condition is unchanged, replace V102, then V103.
c. Check C106-A-B for intermittent short.
d. Check R118 - should not vary more than ±10% of 6000 ohms.
e. Check C107-A-B-C-D for intermittent short.
f. Check T101 for leakage or arcing to ground.
g. Flasher tube may be ending useful life - replace tube.

9.6 FLASHER TUBE FLASHES SAME RATE HIGH - LOW.

a. Check R110 (rpm) for open circuit.

9.7 FLASHER TUBE OPERATES CORRECTLY ON LOW - IONIZES ON HIGH.

a. Readjust trigger element on flasher tube using an insulating rod.

9.8 DIAL LAMP AND TUBE FILAMENTS LIGHT - NO FLASH.

a. Check V103 and replace if necessary.
b. Check T102 secondary for open circuit.

9.9 CALIBRATION OFF BY MORE THAN 1% EITHER SCALE.

a. Replace V101 (12AU7).
b. If "LOW" scale does not line up, readjust internal potentiometer (R106).

9.10 UNABLE TO ADJUST RPM - HIGH.

a. Check R109 for open circuit and correct resistance.
b. Check R104, R107 for shorts, and correct resistance.
c. Check dial drive for looseness.

9.11 UNABLE TO ADJUST RPM - LOW.

a. Check R111 for open circuit and correct resistance.
b. Check dial drive for looseness.
c. Replace V101 (12AU7).

9.12 RPM KNOB BINDS.

a. Check for knob binding on panel.
b. Check that internal wires are not binding drum dial.
c. Check that drum assembly is not pushed too far in on shaft.
d. Lubricate dial shaft, through R110, with petrolatum (unmedicated Vaseline).

9.13 TUBE SOCKET VOLTAGES. Table of tube socket voltages measured from socket pin to ground, unless otherwise indicated. Use a VTVM or a 20,000 ohm-per-volt meter. Voltages may vary ±20%.

Conditions:

S101 set to "STROBOSCOPE LOW"
Dial set to 3600 rpm
Line volts 115 AC

| SYMBOL | TYPE | SOCKET PIN NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| V101 | 12AU7 | +70 | -22 | 0 | 6.3 AC | 6.3 AC | +70 | -20 | 0 | 0 |
| V102 | 6SN7GTA | -8 | +125 | 0 | -7 | +380 | +25 | 6.3 AC | 0 | - |
| V103 | 6X4 | 330 AC | NC | 6.3 AC | 0 | NC | 330 AC | +400 | - | - |
| V104 | S55B | - | 0 | +250 | +250 | 0 | - | - | - | - |

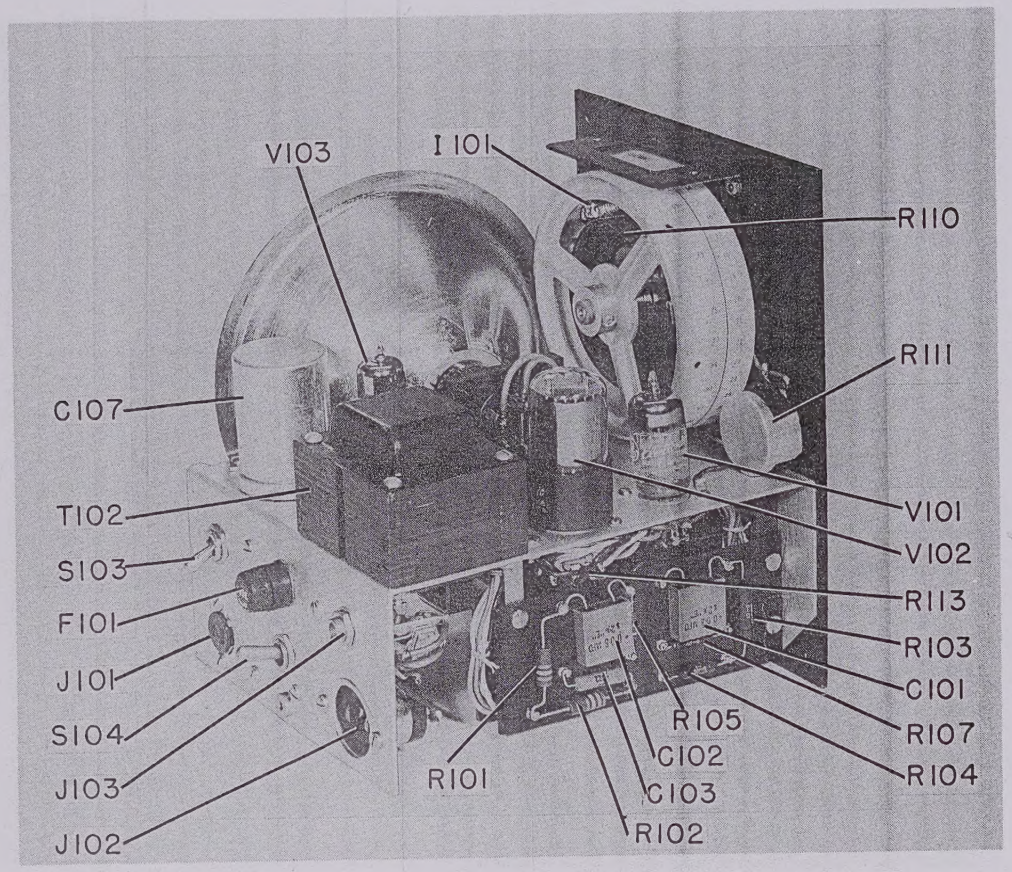



Figure 6. Chassis Top

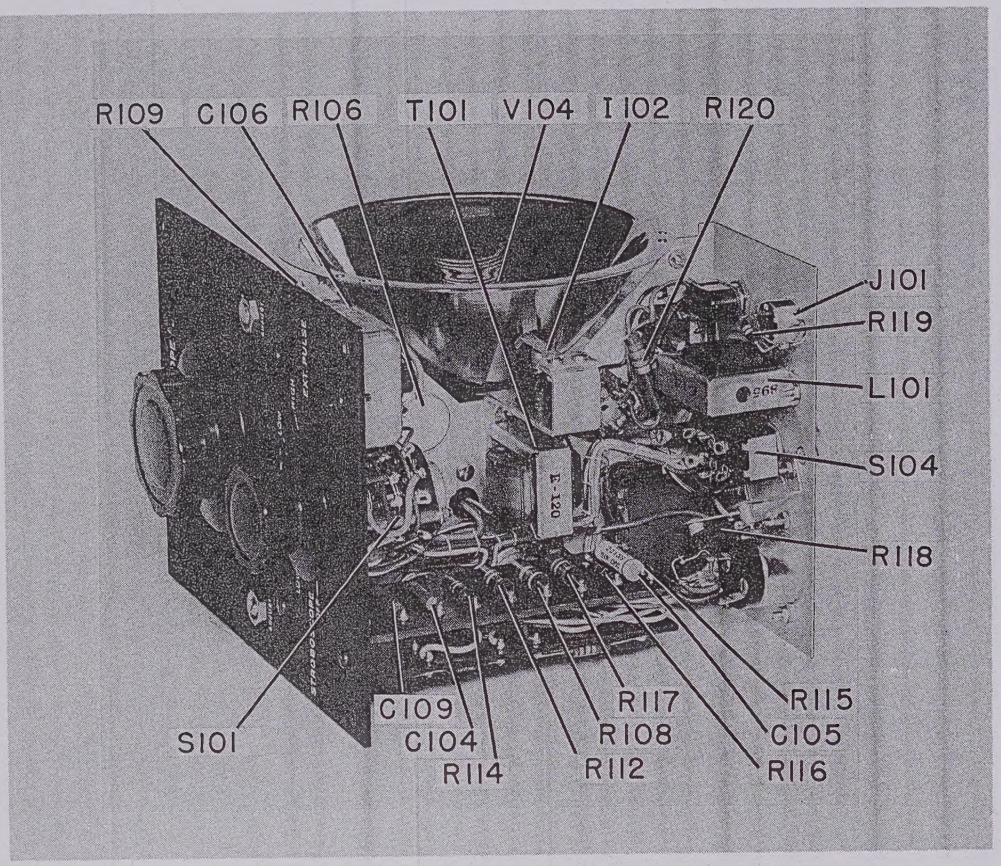



Figure 7. Chassis Bottom